AN INVESTIGATION INTO WATER USAGE AND WATER EFFICIENT DESIGN FOR PERSIAN GARDENS

By

Shaghayegh Moalemzadeh Ansari

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College of Social & Behavioral Science, Linguistic

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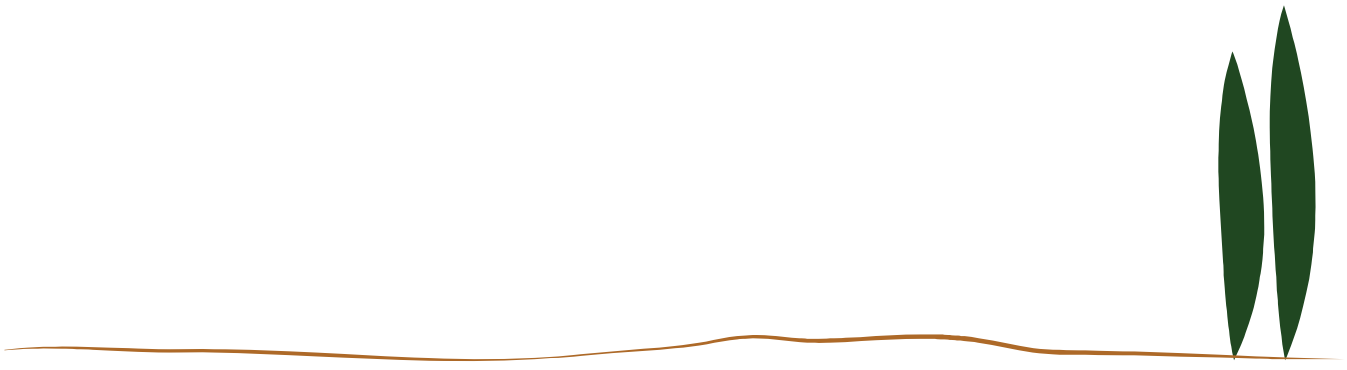


Taleghani Fellowship Report:

Investigation and research into the Persian Gardens, leading this project into a step that these World Heritage Sites might have been known as sustainable construction, but the fact that water scarcity of their region is a serious threaten for all these amazing Gardens. Thus, enhancing and improving these gardens by merging, adding and adapting todays technologies can make them considered as constructions with water and energy conservation design.

Based on nowadays world environment concerns, recognizing renewable and non-renewable sources of energies in a region or site can cause a miracle. Since, almost all Persian Gardens located in regions with arid and semi-arid climate, water poverty as a biggest issue and nonrenewable energy should be included as a problematic concern.

There are many available active and passive strategies that can be applied in these heritage sites which decrease water consumption either directly or indirectly. Such as water harvesting, greywater reuse, photovoltaic panels and material changes. Water known as a vital element of each garden for irrigation purposes, but in Persian Garden water is more than a functional element. Thus, finding a way to provide and recycle water beside the underground sources is necessary. Subterranean, springs and wells are resources of water for Persian gardens which renew so slowly or non-renew these days. Being so close to a city with considerable population lunches and idea of using greywater for irrigation in these gardens.

In this research, the doable options for energy conservation design for these sites will be discussed, then comparing some case studies in all over world where greywater reusing water system for irrigation is happening will be next step. In conclusion, greywater reusing system in urban scale in order to irrigate a filed or garden will be investigating on a Shazdeh Garden as a main case study of this research.

Vernacular Persian Gardens

Persian Gardens identified as *Bagh-e-Irani* in Iran, are one of the ancient and historical places in Iran. These gardens may instigate as early as 4000 BCE which the most famous ones can be found in Iran. Currently there are twelve Persian Gardens that authorized as World Heritage Sites which all of them follow the same prototype.

Problem Statement

As an Iranian architect, there has been a question in my mind regarding how an ancient architectural heritage can become a rich resource for an inspiration rather than a burden or limitation.

I am from the city of Kerman, in Iran. It is located in an arid region that has hot climate but with springs and subterranean water as a resource. In the history of Kerman, when people migrated from one city to another, they had to go through the desert passage for many days. Those people were often looking for green oasis like spaces where the existence of trees and water was considered a miracle for them.

Availability of these green gardens based on vernacular sustainable strategies which comes at an ancient time where access to technology was not available intrigued my interest to investigate and analyze the principles of these gardens. In result, the poverty of the water in these harsh lands which is the most vital factor of these gardens drew my attention.

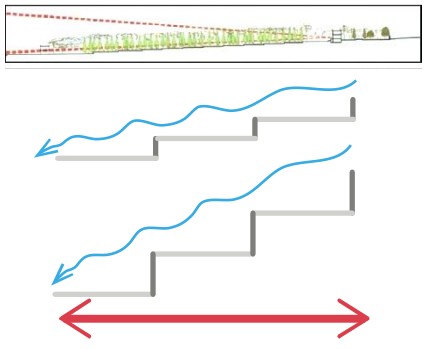
In conclusion, integrating technology with vernacular strategies is what this research proposing to find a propitiate replacement for these garden's water resource. Using underground water resources for centuries in these regions reduce the underground level of water. Investigating the opportunities and possibilities of the proposal solution is the next step of this research.

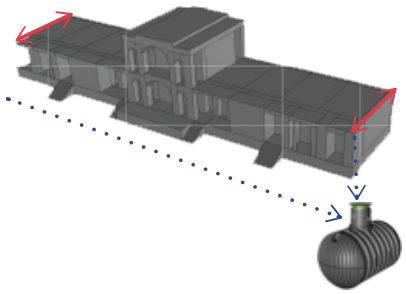
Proposal Approaches to Optimization of Energy Consumption in Persian Garden by Integration to the Technology

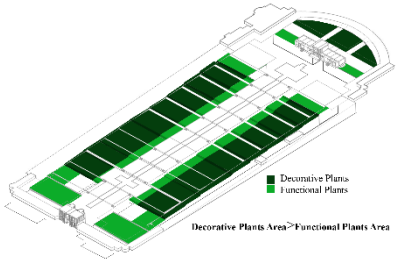
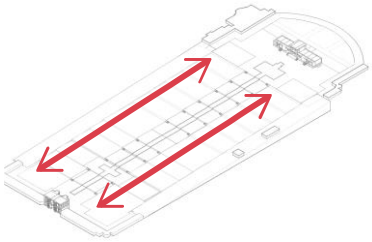
Promoting, enhancing and developing Persian Gardens in purpose of saving them from scarcity of water, which is vital for these heritage sites by proposing some simple approaches based on technologies of design conservation, is the focus of this research. Changing and applying these strategies is a challenge since these gardens are World Heritage Sites.

Water and Energy Efficiency Adaptation Techniques on Shazdeh Garden

List below id the options that may be doable for Shazdeh Garden in order of energy and water efficacy performance of these gardens. Referring to the following table, which is the part of result of this research, investigating into the constituents of this garden to evaluate the possibilities, can be the first step of this process.

Persian Garden Prototype Factors	Proposed Energy Efficiency Strategy	How it Can be Applied
Surrounding Environment Surrounding Walls	1. Vast vacant land surrounding this garden is a good chance to find a proper place to put PV panels for active strategies power needed purposes. 2.A city next to this garden can be a good opportunity to apply grey water approach	
Geometry N	1. Changing the slope ratio that is aligned from south to increase time of contact, so less water will be needed for evaporation. Since the main fountains, pools and stream which located at the middle are the most effective elements of evaporation in this garden, changing the sizes and capacity of them can be helpful in decreasing the water consumption.	

Building	1. Since buildings in this garden is now using as resorts, restaurants, stores and museums, the occupancies and users will need to use water, gas and electricity as all type of buildings need to. So beside all passive vernacular strategies that they have, approaches like greywater system can be necessary and helpful.	

Vegetation	1. Locating trees and flower types to see the possibilities of replacing some types which need more water with other types that can have the same function with needs of less water than them. 2. Transferring some types of vegetables and fruit trees which were used for users (King and his servants) in past.	
Shading Devices	1. Shading area can be considered as the most effective and simplest strategy that keeps this garden alive and amazing among this harsh climate by creating thermal comfort inside of this garden. But adding more shading devices in some areas that might cause shortages in water consumption in purpose of irrigation or evaporation, will be helpful.	 The Areas that can have less shading trees
Water	1. Assigning domestic greywater approach. 2. Applying rainwater harvesting strategy. 3. Evaluating the possibilities of using greywater in a bigger scale for gardening and irrigation. Collecting greywater from Mahan city which is located in 3.72 miles, south east of the garden, and treat the water by using solar energy either directly or indirectly can be the most helpful strategy for this garden. Because water is the vital segment of whole system.	 Mahan City Area

Conclusion and Achievements from Case Studies

The greywater system in urban scale includes steps as follows:

I. The Collection System

There are various ways to collect the greywater from the households, moreover, it is essential to separate flushing toilet water that is known as Blackwater, from greywater. For being sure that the two different types of waste water separation happens correctly, a one way direction valve is installed, to allow passage of excess GW into the central sewage system. [1]

II. The Treatment System

In this step, based on the function of the water after it recycles, the treatment plan should be decided. The treatment system consists commonly of a settling element, a screening/filtering component and biological process that can include as well membrane technology element or constructed wetlands components.

III. Storage

Storage is implemented for the raw GW, prior to treatment and for treated GW prior to its application. The detention of the treated GW should not exceed several days. The storage tanks should be positioned above or below the ground however, not risking local residents. The storage should be made of prefabricated materials off-site.[2]

IV. Pumping Incoming GW and Treated Water Distribution

The size and the power of the pumping should be recognized and chosen based on the purpose of the use such as using for a house or an irrigation.

V. Maintenance

This step of the process depends on the local authorities and needs on site. Maintenance refers to annual regular operation of the system.

VI. Greywater Application

For most irrigation systems it might need to use the dripped irrigation system to avoid direct contact of a human skin.

VII. Greywater Quality

This factor is the most important issue related to reuse. Generally it can be divided in two main sections of irrigation and house uses.

[1] Oron, Gideon, Mike Adel, Vered Agmon, Eran Friedler, Rami Halperin, Ehud Leshem, and Daniel Weinberg. "Greywater use in Israel and worldwide: Standards and prospects." Water research 58 (2014): 92-101. Page: 97